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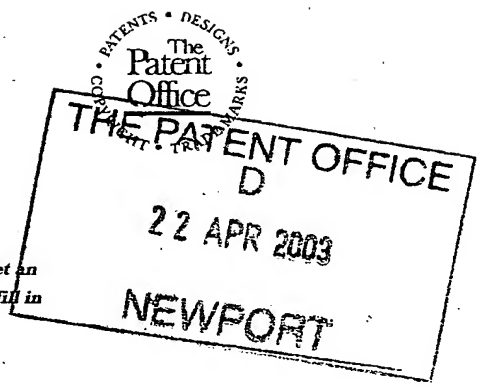

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1. Your reference — A10871GB-DJL

2. Patent application number *(The Patent Office will fill in this part)* — 0309039.6 — 22 APR 2003

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Markem Technologies Limited
Highfields Science Park
Nottingham
NG7 2QN

Patents ADP number *(if you know it)* 8618122001

If the applicant is a corporate body, give the country/state of its incorporation — United Kingdom

4. Title of the invention — Apparatus for Controlling a Ribbon Transport Mechanism

5. Name of your agent *(if you have one)* — Forrester Ketley & Co.

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Chamberlain House
Paradise Place
Birmingham
B3 3HP

Patents ADP number *(if you know it)* — 133005

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7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

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11. I/We request the grant of a patent on the basis of this application.

Signature: Forrester Ketley & Co.
Forrester Ketley & Co.

Date: 17 April, 2003

12. Name and daytime telephone number of person to contact in the United Kingdom

David J Lucking
0121 236 0484

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DUPLICATE

PATENTS ACT 1977

A10871GB/DJL

Title: Apparatus for Controlling a Ribbon Transport Mechanism

Description of Invention

This invention relates to an apparatus for controlling a ribbon transport mechanism of a ribbon feed system, such as for example only, in a printer. Such a printer typically includes a ribbon storage spool for storing ribbon, and a ribbon take-up spool for taking up used ribbon, a ribbon path between the storage and take-up spools though an operating station where a print head is provided. In use the print head may move relative to the stationary ribbon, or the ribbon may move relative to the stationary or moving print head, whilst the print head is actuated to remove marking medium from the ribbon and to deposit the marking medium on a substrate.

The ribbon tends to be thin and physically of restricted strength, with the result that the ribbon may break if subjected to too much tension. Thus precise control of the ribbon tension is desirable to ensure print quality and to ensure that the ribbon is uniformly wound onto the take-up spool. Accordingly it is a requirement in such a ribbon feed system carefully to control the tension of the ribbon as it is transported along the ribbon feed path from the storage to the take-up spool.

In one prior proposal, in which the take-up spool is driven to transport the ribbon, and the storage spool is dragged, the storage spool is provided with a slipping clutch in an effort to maintain ribbon tension within boundary values. However, particularly where the storage spool is relatively full compared to the take-up spool, the inertia of the storage spool can result in substantial tension on the ribbon when the ribbon transport mechanism is operated, leading to ribbon breakage.

In another prior proposal, in which both the storage and take-up spools are driven by respective motors during ribbon transport, a measure of ribbon tension is obtained by determining the level of current consumed by one or other of the motors. However this is a complex solution requiring pre-calibration of the motors used to determine their overall drive characteristics.

According to one aspect of the invention we provide an apparatus for controlling a ribbon feed mechanism of a ribbon feed system which includes a base, a ribbon storage spool, a ribbon take-up spool, a ribbon path between the storage and take-up spools through an operating station where a work operation is carried out which utilises the ribbon, the ribbon transport mechanism in use, transporting the ribbon along the feed path between the storage and take-up spools, the apparatus including a mounting structure for mounting at least one of the storage and take-up spools so as to permit the respective spool to move non-rotationally relative to the base in response to changes in ribbon tension occurring in the ribbon feed system, and a sensor device which is sensitive to such non-rotational spool movements to provide an input which is dependant upon the extent of non-rotational spool movement, to a controller, the controller controlling operation of the ribbon transport mechanism in response.

Thus utilising the present invention, a relatively simple and inexpensive means for controlling ribbon tension may be provided which is independent of motor characteristics or motor type, so that the transport mechanism may more accurately be controlled to avoid ribbon breakages.

The invention has particularly but not exclusively been devised for use with a ribbon feed system in which both the ribbon take-up, and ribbon storage spools are driven during ribbon transport, which may be during or after a work operation is carried utilising the ribbon. Thus preferably the apparatus includes for the storage spool a first mounting structure, and for the take-up spool, a second mounting structure, both of the first and second mounting structures permitting respective non-rotational spool movements relative to the base, and

there being a sensor device for each mounting structure to sense respective non-rotational spool movements attributable to changes occurring in the ribbon tension. Thus both sensor devices may provide respective inputs to the controller which may control the ribbon transport mechanism. For example the ribbon transport mechanism may include a motor for each of the storage and take-up spools, which motors may individually be controlled by the controller in response to the inputs from the respective sensor devices, to maintain ribbon tension within predetermined values.

It will be appreciated that as the amount of ribbon on each of the storage and take-up spools changes as ribbon is wound onto the take-up spool, and particularly as the ribbon diameters on the respective spools change, ribbon tension will be affected, and resulting movements of the or the respective mounting structures due to changes in ribbon tension, will change.

Typically the controller would determine a measure of the or at least one of the respective spool diameters, in order to control rotation of the spools to achieve a desired amount of ribbon feed during and/or subsequent to a printing operation. This may be achieved by calculation or by ribbon diameter measurement as desired.

Accordingly, preferably the controller not only uses information received from the sensors, but also uses information indicative of the amount of ribbon, e.g of the ribbon diameter on at least one of the spools in order to control ribbon transport mechanism operation to control the ribbon tension .

Although the spool or spools may be mounted on the base by any suitable kind of mounting structure, the or each mounting structure may include a spool mounting part provided in an opening in the base. The spool mounting part may be attached to the base by a connecting member which permits the spool mounting part, and hence the spool, to move relative to the base in response to changes in ribbon tension. For example, the base may include a plate-like member providing the opening, and the connecting member may

include a bridge which is integral with the plate-like member and the spool mounting part. In this case the sensor device may include a transducer which may be provided between the base and the spool mounting part to sense movements of the spool mounting part relative to the base. The transducer may be a proximity sensor, a strain gauge or any other suitable sensor device.

The opening in the base in which the spool mounting part is provided, may substantially surround the spool mounting part or may be provided at an edge of the base.

Preferably, the spool mounting part includes a spindle on which the spool is mounted. It will be appreciated that changes in ribbon tension will tend to be transmitted to the spindle and hence to the spool mounting part, resulting in spool mounting part movements relative to the base.

The spindle may be an idler spindle but preferably the spindle is a driven shaft of a motor the rotation of which to achieve ribbon transport, is controlled by the controller. Thus the motor is preferably provided on the spool mounting part.

According to a second aspect of the invention we provide a method of controlling a ribbon transport mechanism of a ribbon feed system which includes a base, a ribbon storage spool, a ribbon take-up spool, a ribbon path between the storage and take-up spools through an operating station where a work operation is carried out which utilises the ribbon, the ribbon transport mechanism in use, transporting the ribbon along the feed path between the storage and take-up spools, the method including providing at least one of the storage and take-up spools on a mounting structure which permits the respective spool to move non-rotationally relative to the base in response to changes in ribbon tension occurring in the ribbon feed system, and sensing such non-rotational spool movements with a sensor device, providing an input which is dependant upon the extent of non-rotational spool movement, from the sensor

device to a controller, and controlling operation of the ribbon transport mechanism in response.

The method of the second aspect of the invention may include sensing movements of both of the ribbon storage and take-up spools with respective sensor devices, and providing inputs dependent upon the extents of non-rotational spool movements from the sensor devices to the controller.

According to a third aspect of the invention we provide a method of determining when a ribbon in a ribbon feed system has broken, the ribbon feed system including in a base, a ribbon storage spool, a ribbon take-up spool, a ribbon path between the storage and take-up spools through an operating station where a work operation is carried out which utilises the ribbon, and a ribbon transport mechanism for transporting the ribbon along the feed path between the storage and take-up spools, the method including providing at least one of the storage and take-up spools on a mounting structure which permits the respective spool to move non-rotationally relative to the base in response to changes in ribbon tension occurring in the ribbon feed system, and sensing with a sensor device a movement of the mounting structure which indicates that the ribbon has broken, and providing an input from the sensor device to a controller which operates an indicating device which indicates that the ribbon has broken.

Embodiments of the invention will now be described with reference to the accompanying drawing which is an illustrative view of a ribbon feed system and an apparatus for determining ribbon tension in accordance with the invention.

Referring to the drawing, a ribbon feed system 10 is part of a printing machine P in this example. Ribbon 11 is coated with marking medium or ink, which is deposited on a substrate 12 during a printing operation, carried out at a operation station 14, where a print head 15 is provided. In this example, the print head 15 is a so called thermal print head having a plurality of heating elements arranged in a linear array which is transverse to the direction of

movement of the ribbon 11 through the printing machine P. During printing, while there is relative movement between the print head 15 and the substrate 12, the heating elements are selectively energised, to melt and thus remove pixels of marking medium from the ribbon 11, which pixels are deposited on the substrate 12. The ribbon 11 may be stationary during printing with the print head 15 moving along the ribbon 11 and substrate 12, or vice versa, or the ribbon 11 and substrate 12, and the print head 15 may all be relatively moving.

Thus either after a printing operation, and/or during printing the ribbon 11 needs to be advanced to bring fresh ribbon 11 to the operation station 14 for a subsequent printing operation.

The ribbon feed system 10 includes a base 18, a ribbon storage spool 19, and a ribbon take up spool 20. The spools 19, 20 are both rotatable relative to the base 18 so that ribbon 11 may be fed off the storage spool 19, and pass around a ribbon feed path where a plurality of guide rollers 22 are provided, through the operation station 14, and thence on to the take-up spool 20.

In use, ribbon may be wound from spool 20 to spool 19, for example to effect ribbon saving functionality, in which case the roles of the spools 19, 20 would be reversed with the storage spool 19 becoming the take-up spool and the take-up spool 20, the storage spool. In this description however, single direction ribbon movement is assumed, although the invention may be applied to bi-directional ribbon feed systems.

In this example, each of the spools 19, 20 has a drive motor 19a, 20a which provide a ribbon transport mechanism. The drive motors 19a, 20a each have driven shafts which provide spindles 21, 22 on which the respective storage and take-up spools 19, 20 are mounted. The drive motors 19a, 20a are controlled by a controller C which co-ordinates ribbon 11 drive, with printing operations.

In accordance with the invention, each of the storage 19 and take-up 20 spools are mounted on respectively, a first mounting structure 25 and a second

mounting structure 26. In this example both the first and second mounting structures 25, 26 are substantially similar and thus only the construction of mounting structure 25 will be described.

The mounting structure 25 includes a mounting part 28 on which the storage spool 19 and its drive motor 19a are mounted. The base 18 is in this example a plate-like member, and the mounting part 28 is provided as an island in the base 18, which is connected to the base 18 by a connecting member 30 which provides a bridge.

In this example, the connecting member or bridge 30 is integral with the plate-like base member 18 and the mounting part 28, and the island mounting part 28 is formed by a space 31 which substantially surrounds the mounting part 28. Thus the mounting part 28 is provided in an opening 33 in the base plate-like member 18.

Because the connecting member or bridge 30 is small, it will be appreciated that during ribbon 11 transport or otherwise e.g. during printing, as tension in the ribbon 11 around the ribbon feed path may change, and the ribbon 11 will tend to exert changing radial i.e. non rotational forces on the spindles 21, 22 on which the spools 19, 20 are mounted, and so small movements of the mounting part 28 relative to the base 18 may occur.

It can be seen that along the space 31, there is a wider space part 35 where a sensor device 36 is provided. The sensor device 36 is a transducer, such as a proximity sensor or strain gauge, which is sensitive to movements of the mounting part 28 relative to the base 18 due to changes in the ribbon tension. The transducer 36 provides an input signal to the controller C which thus depends upon the amount of mounting member 28 movement, which in turn is dependent upon the tension in the ribbon 11. Thus by suitable calibration, a determination of the tension of the ribbon 11 along the ribbon feed path of the system 10 may be made.

In response to the input signals from the two transducers 36 of the first and second mounting structures 25, 26, the controller C may operate the drive motors 19a, 20a to maintain the tension of the ribbon 11 within predetermined values. Thus if the controller C determines that the ribbon 11 is too taut, the storage spool 19 of the ribbon transport mechanism may be arranged to be driven at a slightly faster rate or the take-up spool 20 at a slightly slower rate to relieve the ribbon tension, and vice versa.

Where the ribbon 11 is moved through the operation station 14 during a printing process, it will be appreciated that the ribbon 11 may be fed at a differential or the same speed as the substrate 12, or in a printing machine P in which the print head 15 too moves during printing, the ribbon 11 and substrate 12 may be driven at the same speed, with the print head 15 speed being adjusted to achieve a desired differential speed between the print head 15 and the substrate 12.

In the example shown in the drawings, the analogue signals from the sensor devices (transducers) 36 are conditioned in conditioning circuits 32, converted by analogue to digital converters 38, 39 to digital signals, and a determination of ribbon tension is made in the controller C by comparing the digital signals from the two transducers 36, which in this example, are sensitive to spool movements in substantially opposite directions relative to the base 18.

In another example, only one of the spools 19, 20 may be provided on a mounting structure 25, 26 which permits of non-rotational movements of the spool 19, 20 relative to the base 18. In this case a single transducer 36 may be provided to sense such non-rotational movements, and the controller C would be programmed to determine from the one input, the tension of the ribbon 11. Of course if desired, more than one transducer 36 may be provided for the or each mounting structure 25, 26, each being sensitive to mounting part 28 movements in different directions.

It will be appreciated that as the amount of ribbon 11 on each of the storage and take-up spools 19, 20 changes as ribbon is wound onto the take-up spool, and particularly as the ribbon diameters on the respective spools 19, 20 change, ribbon tension will be affected, and resulting movements of the respective mounting structures 25, 26 due to changes in ribbon tension, will change.

Typically the controller C would determine a measure of the respective spool 19, 20 diameters, in order to control rotation of the spools 19, 20 to achieve a desired amount of ribbon 11 feed during and/or subsequent to a printing operation. This may be achieved by calculation or by ribbon diameter measurement as desired.

Accordingly, preferably the controller C not only uses information received from the sensors 36, but also uses information indicative of the ribbon diameter on at least one of the spools 19, 20 in controlling ribbon transport mechanism operation to control the ribbon 11 tension .

Various modifications may be made without departing from the scope of the invention.

For example, in the example described, both spools 19, 20 are driven by respective motors 19a, 20a, but in another example, only the take-up spool 20 may be driven, directly or via a transmission, with the storage spool 19 being dragged via a slipping clutch. In this event, the determination of the ribbon tension may be used by the controller C to control the speed of the take-up spool motor 20a. However where there is a controllable slipping clutch, the resistance of the clutch to slipping may be controlled by the controller C depending upon ribbon tension.

In the example described, the motors 19a, 20a have driven shafts which provide the spindles 21, 22 but in another example the motors 19a, 20a may drive the spools 19, 20 indirectly through a transmission.

Although in the examples described, the mounting structures 25, 26 have been provided by islands substantially surrounded by the base plate-like member 18, and connected to the base 18 by integral bridge connecting members 30, in another example, a mounting structure 25, 26 may be provided by a mounting part 28 otherwise connected to the base 18, although desirably in an opening in the base 18, which may be at an edge of the base 18 as desired.

Instead of proximity sensors or strain gauges, any other suitable transducers or other sensor devices may be provided, such as for example optical sensor devices, to sense non-rotational spool movements relative to the base as a result of changing ribbon tensions.

It will be appreciated that in the event of a ribbon 11 breakage, the sensor device 36 or devices may sense a more sudden movement of the mounting part 28 than may otherwise occur in normal use. Accordingly, the input to the controller C may immediately indicate that there has been a ribbon breakage, and the controller C may respond by stopping the or both of the motors 19a, 20a. Moreover, the controller C may operate an indicating device 40 such as a visual or audible warning, to indicate that a ribbon breakage has occurred. The controller C will know exactly at which point of the operating cycle the ribbon breakage has occurred and this information may be extractable from the controller C for diagnostic use, for example to determine if there is a particular fault with the ribbon feed system 10.

The features disclosed in the foregoing description, or the following claims, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

CLAIMS

1. An apparatus for controlling a ribbon transport mechanism of a ribbon feed system which includes a base, a ribbon storage spool, a ribbon take-up spool, a ribbon path between the storage and take-up spools through an operating station where a work operation is carried out which utilises the ribbon, the ribbon transport mechanism in use, transporting the ribbon along the feed path between the storage and take-up spools, the apparatus including a mounting structure for mounting at least one of the storage and take-up spools so as to permit the respective spool to move non-rotationally relative to the base in response to changes in ribbon tension occurring in the ribbon feed system, and a sensor device which is sensitive to such non-rotational spool movements to provide an input which is dependant upon the extent of non-rotational spool movement, to a controller, the controller controlling operation of the ribbon transport mechanism in response.

2. An apparatus according to claim 1 wherein both the ribbon take-up, and ribbon storage spools are driven during ribbon transport.

3. An apparatus according to claim 2 wherein ribbon transport occurs during or after a work operation is carried utilising the ribbon.

4. An apparatus according to claim 2 or claim 3 wherein the apparatus includes for the storage spool a first mounting structure, and for the take-up spool, a second mounting structure, both of the first and second mounting structures permitting respective non-rotational spool movements relative to the base, and there being a sensor device for each mounting structure to sense respective non-rotational spool movements attributable to changes occurring in the ribbon tension.

5. An apparatus according to claim 4 wherein both sensor devices provide respective inputs to the controller which controls the ribbon transport mechanism.

6. An apparatus according to claim 5 wherein the ribbon transport mechanism includes a motor for each of the storage and take-up spools, which motors are individually controlled by the controller in response to the inputs from the respective sensor devices, to maintain ribbon tension within predetermined values.

7. An apparatus according to any one of the preceding claims wherein the controller uses information indicative of the amount of ribbon on at least one of the spools in controlling ribbon transport mechanism operation to control the ribbon tension .

8. An apparatus according to any one of the preceding claims wherein the spool or spools are mounted on the base by a mounting structure including a spool mounting part provided in an opening in the base.

9. An apparatus according to claim 8 wherein the spool mounting part is attached to the base by a connecting member which permits the spool mounting part, and hence the spool, to move relative to the base in response to changes in ribbon tension.

10. An apparatus according to claim 9 wherein the base includes a plate-like member providing the opening, and the connecting member includes a bridge which is integral with the plate-like member and the spool mounting part.

11. An apparatus according to claim 10 wherein the sensor device includes a transducer provided between the base and the spool mounting part to sense movements of the spool mounting part relative to the base.

12. An apparatus according to any one of the preceding claims wherein the transducer is one of a proximity sensor and a strain gauge

13. An apparatus according to any one of claims 10 to 12 where dependant upon claim 10 wherein the opening in the base in which the spool mounting part is provided, substantially surrounds the spool mounting part.

14. An apparatus according to any one of the preceding claims wherein the spool mounting part includes a spindle on which the spool is mounted.

15. An apparatus according to claim 14 wherein the spindle is a driven shaft of a motor the rotation of which to achieve ribbon transport, is controlled by the controller.

16. An apparatus for controlling a ribbon transport mechanism substantially as hereinbefore described with reference to and/or as shown in the accompanying drawing.

17. A method of controlling a ribbon transport mechnaism of a ribbon feed system which includes a base, a ribbon storage spool, a ribbon take-up spool, a ribbon path between the storage and take-up spools through an operating station where a work operation is carried out which utilises the ribbon, the ribbon transport mechanism in use, transporting the ribbon along the feed path between the storage and take-up spools, the method including providing at least

one of the storage and take-up spools on a mounting structure which permits the respective spool to move non-rotationally relative to the base in response to changes in ribbon tension occurring in the ribbon feed system, and sensing such non-rotational spool movements with a sensor device, providing an input which is dependant upon the extent of non-rotational spool movement, from the sensor device to a controller, and controlling operation of the ribbon transport mechanism in response.

18. A method according to claim 17 which includes sensing movements of both of the ribbon storage and take-up spools with respective sensor devices, and providing inputs dependent upon the extents of non-rotational spool movements from the sensor devices to the controller.

19. A method of controlling a ribbon feed mechanism substantially as hereinbefore described with reference to the accompanying drawing.

20. A method of determining when a ribbon in a ribbon feed system has broken, the ribbon feed system including in a base, a ribbon storage spool, a ribbon take-up spool, a ribbon path between the storage and take-up spools through an operating station where a work operation is carried out which utilises the ribbon, and a ribbon transport mechanism for transporting the ribbon along the feed path between the storage and take-up spools, the method including providing at least one of the storage and take-up spools on a mounting structure which permits the respective spool to move non-rotationally relative to the base in response to changes in ribbon tension occurring in the ribbon feed system, and sensing with a sensor device a movement of the mounting structure which indicates that the ribbon has broken, and providing an input from the sensor device to a controller which operates an indicating device which indicates that the ribbon has broken.

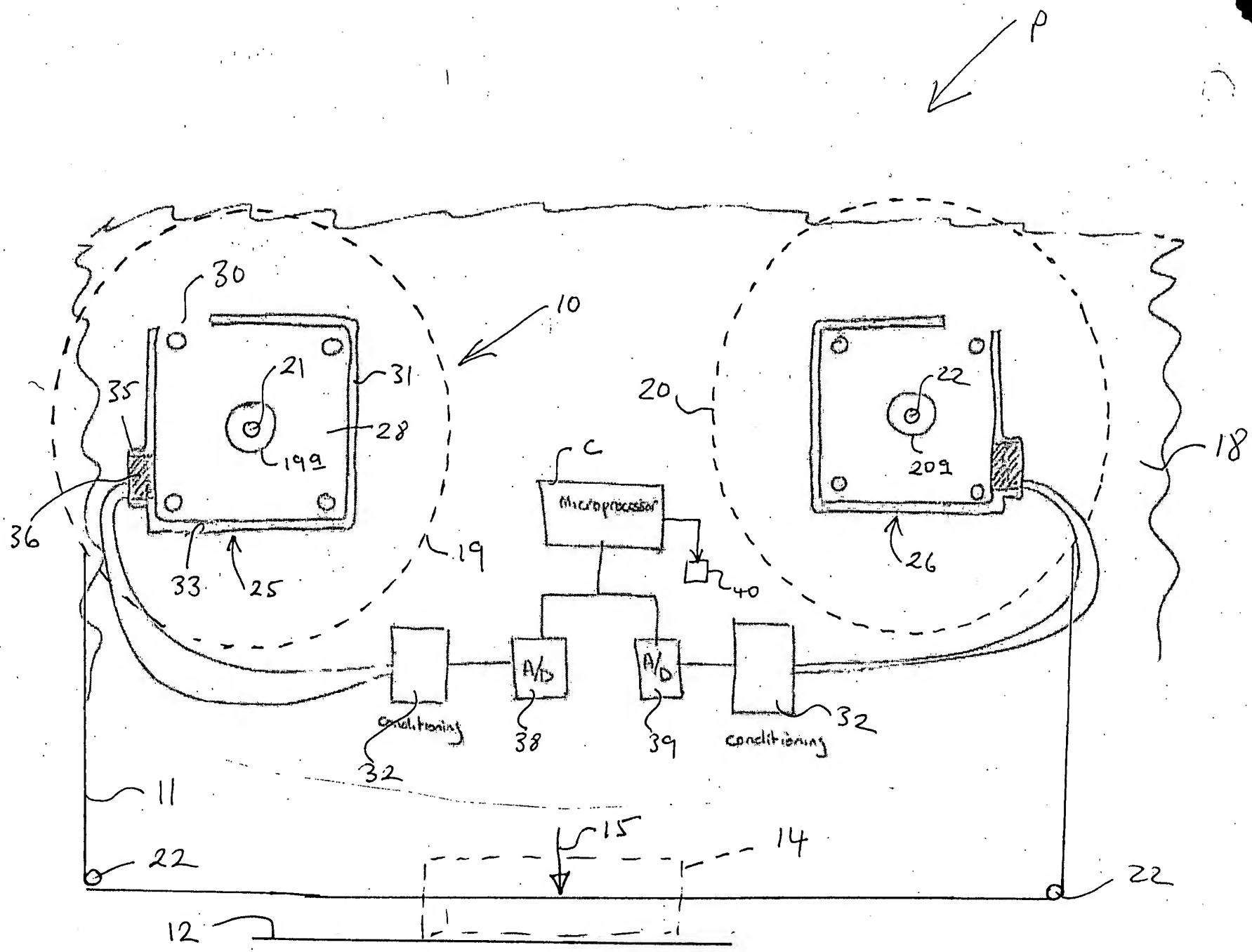
21. A method of determing when a ribbon has broken substatially as hereinbefore decsribed with reference to the accompanying drawings.

22. Any novel feature or novel combination of features described herein and/or as shown in the accompanying drawing.

ABSTRACT

Title: Apparatus for Controlling a Ribbon Transport Mechanism

An apparatus for controlling a ribbon transport mechanism of a ribbon feed system 10 which includes a base 18, a ribbon storage spool 19, a ribbon take-up spool 20, a ribbon path between the storage 19 and take-up 20 spools through an operating station 14 where a work operation is carried out which utilises the ribbon 11, the ribbon transport mechanism 19a, 20a in use, transporting the ribbon 11 along the feed path between the storage 19 and take-up 20 spools, the apparatus including a mounting structure 25, 26 for mounting at least one of the storage 19 and take-up 20 spools so as to permit the respective spool to move non-rotationally relative to the base 18 in response to changes in ribbon tension occurring in the ribbon feed system 10, and a sensor device 36 which is sensitive to such non-rotational spool movements to provide an input which is dependant upon the extent of non-rotational spool movement, to a controller C, the controller C controlling operation of the transport mechanism 19a, 20a in response.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